OP
Assoc. of Towns

CAN SPRING BREAKUP BE PREVENTED
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Spring breakup of a highway pavement results from "frost action", which is the freezing and subsequent thawing of water in the soils beneath the pavement surface, and, an inadequate foundation.

At one time it was believed that road surfaces heaved in the winter simply because of the expansion of water in the soil due to freezing. Since water expands only about 9 percent as it freezes it becomes obvious that this expansion could only account for a heave of a fraction of an inch for most soils whereas heaves of several inches or even two to three feet are not uncommon. Field observations and laboratory tests have since indicated that surface heave is caused by the <u>growth</u> of ice lenses or layers in the soil as shown in figure 1b.

During the melting period, the excess water from the melting ice lenses cannot drain downward through the impervious, still frozen soil below. It, therefore, tends to drain upward into the base (figure 1c) and may even emerge through cracks in the pavement. If the pavement base is inadequate either because it is too thin or is not a good granular material, or both, pavement breakup will occur under repeated deflection due to traffic loads on the weakened foundation soils. Fine material will be pumped from beneath the wearing course and there will be further distress to the wearing course due to loss of material.

Knowing that spring breakup is related to frost action and an inadequate pavement section (wearing course, base course and subbase), we must examine these and determine what must be done if we are to prevent spring breakup.

Three basic conditions must all exist before ice lenses or layers form and grow. If any one of these can be eliminated there will be no frost action. These are: (1) freezing temperature in the soil; (2) a supply of ground water sufficiently close to the frost line to feed the growing ice layers; (3) soil material having favorable characteristics for rapid migration of capillary water from the water table to the ice lense. These soils are termed "frost-susceptible" soils. Frost-susceptible soils include silts, fine sands and silts and the so-called "dirty" gravels. Clays are not ordinarily considered to be frost-susceptible, clay with layers of silt, however, would be. The only soils that can be considered to be non-frost-susceptible are very clean mixtures of sand and gravel.

Freezing temperatures are experienced in all parts of New York State so there is little that can be done to prevent frost in the ground. Frost action could theoretically be prevented by removal of water from the frost-susceptible portions of the subgrade. In actual practice however this is not easily done since the soils that are most affected by frost action are also difficult to drain. This tells us that if we

are going to prevent spring breakup that the only positive solution is to remove frost-susceptible soil from beneath the wearing course and replace it with clean granular material.

The discussion up to this point has attempted to define spring breakup, its causes, and ideal ways to eliminate the problem. I am convinced that spring breakup can be prevented but, can Town Superintendents of Highways, operating on a limited budget, prevent spring breakup throughout their towns. For the majority of our New York State towns I am sure that the answer is no. What can be done however is to establish a program that:

1. Is designed to control spring breakup in existing town roads.
2. Will provide design standards for new construction that are adequate to reduce the effects of frost action, and
3. Will encompass a long range reconstruction program that is properly financed to permit reconstruction of existing roads to the standards required for new construction. Simply putting a new top on a damaged wearing surface will not, in most cases,serve as a permanent, satisfactory rehabilitation.

There is no easy or inexpensive way to prevent spring breakup in an existing road. Providing good drainage with

adequate ditches will help to control the damage due to spring breakup but the only way to prevent it is to provide a base for the wearing course that will not loose its strength and become unstable due to frost action. The only materials that meet this criteria are clean granular soil, crushed stone, slag and broken rock.

Since the soils, climatic conditions and traffic intensities are so variable within each town and throughout the State it is not possible to give you specific recommendations for adequate design under all circumstances.

The following general criteria are presented to serve as a guide to limit the occurrence and severity of spring breakup when new construction is planned:

1. Make a soil survey. This includes a visual examination of the terrain to be crossed and auger holes or test pits to determine the nature of the soil and the location of the water table. This information is needed to determine where frost-susceptible material will be encountered and where the grade line should be. In addition, data should be collected concerning the usual depth of frost penetration in your area.
2. The pavement section, which includes the wearing course, base and subbase should be at least 15 inches thick. This minimum should be used only

where traffic is light and the soil conditions are good. For heavier traffic and when soil conditions become less favorable the pavement section should be 18 to 24 inches thick. You will have to classify your road system according to use. Streets in a subdivision will have lesser requirements than heavily travelled roads.

3. The wearing course should have a minimum thickness of 3 inches. After deducting the wearing course no pavement section should have less than 12 inches of clean, non-frost-susceptible granular material. The remainder of the pavement section can be constructed of moderately frost-susceptible material.

The specifications for non-frost-susceptible material should require a clean, sound, sand and gravel having from 30 to 65 percent passing the 1/4 inch sieve and not more than 10 percent passing the number 200 sieve. Moderately frost-susceptible material should have not more than 70 percent passing the number 40 sieve and not more than 15 percent passing the number 200 sieve.

4. The grade line should be as high as practical. A grade line 4 feet above the original ground surface is recommended. Where the grade line is

less than two feet above the original ground surface the area should be undercut in order to have the required pavement section. In no case should the grade line be less than 4 feet above the water table.

Look at the roads in your town particularly during the next few months. Look for frost heaves and later for signs of spring breakup. These will probably be located:

1. In cuts that are poorly drained.
2. In transitions from cut to fill.
3. Where there is an abrupt change in subgrade material and drainage
4. Where culverts cross the road.

Controlling spring breakup is not easy. Annual maintenance and adverse criticism from road users are not easy or pleasant either. To this end therefore, you must evaluate the overall spring breakup problem in your town, decide how to get the highest return on your highway dollar, and determine what program is best for your particular situations.

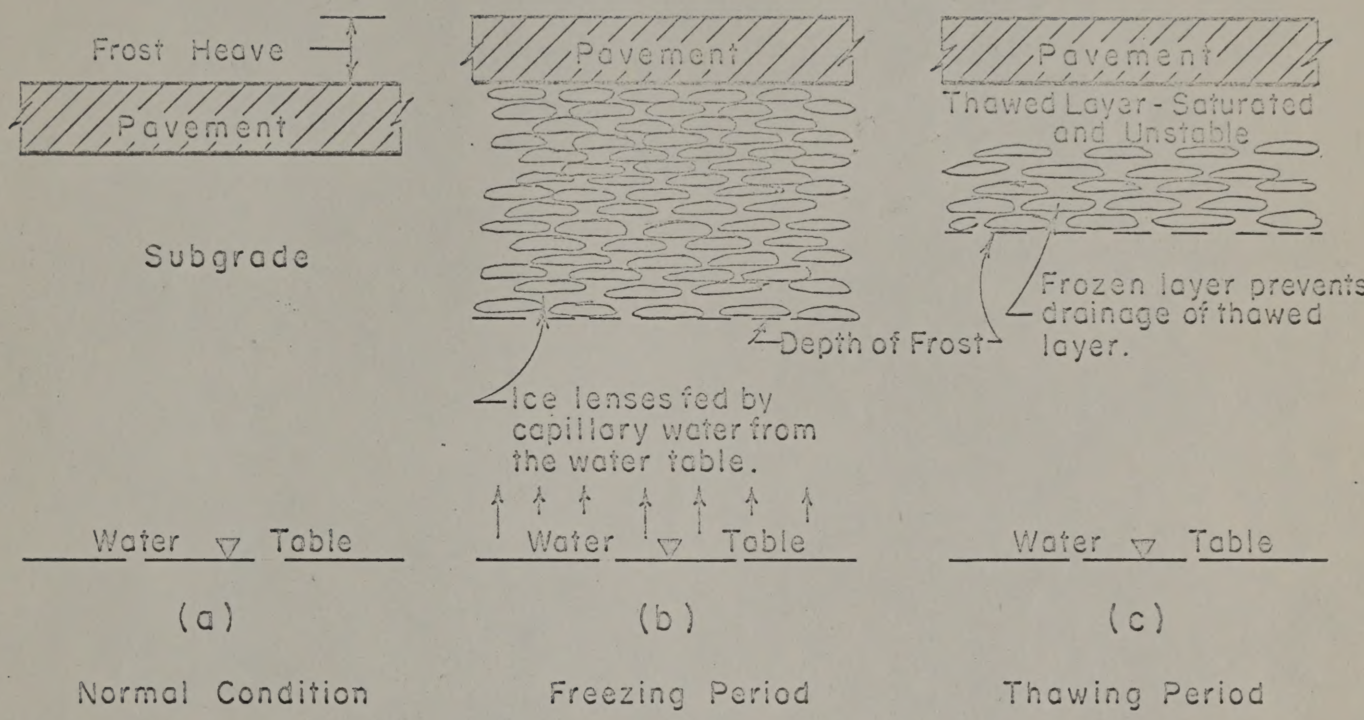
Frost Heave
Pavement
Subgrade
Water Table
(a)
Normal Condition
Pavement
Depth of Frost
Ice lenses fed by capillary water from the water table.
Water Table
(b)
Freezing Period
Pavement
Thawed Layer - Saturated and Unstable
Frozen layer prevents drainage of thawed layer.
Water Table
(c)
Thawing Period

FIGURE 1